largely developed and thickened with mud, &c. In some of my specimens, which have been kept in dilute alcohol, the mud is removed, and the colletoderm appears as a transparent structureless coat covering the polypes and the corallum, and quite distinct from the latter. I have detected this membrane also on the body of the polype of *Coryne decipiens* (Dujardin) and *Clava repens* (mihi), so that *Bimeria* is not singular amongst Zoophytes in the possession of an overcoat.

2. *Eudendrium bacciferum* (Allman), *Garveia nutans* (mihi).

This Zoophyte was also described and figured by me before the Royal Physical Society, in the 'Witness,' and in the 'Edin. New Phil. Journal,' under the same dates as *Bimeria vestita.*

3. *Coryne Briareus* (Allman), *Coryne implexa* (mihi), *Tubularia implexa* (Alder).

The corallum, destitute of polypes, of *Coryne implexa* was described by Mr. Alder, in his Catalogue of Zoophytes of the Northumberland Coast, under the title of *Tubularia implexa.* In August 1859 I found it with its polypes, and described and published it together with *Bimeria vestita.* I have, since the publication of *C. Briareus* by Professor Allman, placed my specimen of *C. implexa* in the latter gentleman's hands; and he is of opinion that it is identical with his. He has, however, unfortunately lost his specimen; so that the coralla cannot be compared with each other. The corallum of *C. implexa* is composed of two very distinct coats, the inner one ringed and horny, the outer one thin, membranous, and not ringed. The latter appears to consist of "colletoderm" in an indurated state.

All the above-mentioned Zoophytes exist in the same localities —the Bimer and Garvey Rocks at Queensferry, Firth of Forth.

Edinburgh, August 1, 1859.

XVIII.—*On the Laws of Evolution of the Organic World during the Formation of the Crust of the Earth.* By H. G. Bronn.

[Concluded from p. 90.]

III. *Results concerning the relations which connect the present state of the organized kingdom with its geological states.*

In all that precedes, we have taken into consideration not only the ancient, but also the present state of things. We have traced the modifications presented to us by the organic world in

is very indestructible, and not coagulable by dilute spirit. It is secreted directly from the ectoderm of the zoophyte, the hard corallum being afterwards secreted beneath it. It is probably a modification of chitine.

the ancient periods, not only to the threshold of the present creation, but also into its very heart. We have seen that these modifications do not by any means all cease at the threshold of existing nature, but that they often continue their course without interruption, so that it becomes difficult for us to say exactly where this threshold is to be found. The groups of plants or animals which were in course of rapid diminution at the close of the geological ages have continued diminishing in the existing epoch : amongst all the fossil species the marine Mollusca are those with which we are best acquainted, and the study of which is most decisive upon this point. Those, on the contrary, which were in course of augmentation have continued their development. At first there existed a certain number of orders and suborders entirely foreign to our existing creation; and all the genera, with the exception of from 1 to 3 per cent., were different from those of the present day. By degrees the number of these foreign types diminished, and the number of genera which have persisted to our days became more and more considerable. In the sequence of ages this number rose gradually from 20 to 40, 60, 80, 90, and, lastly, 100 per cent. By degrees, and this even at the close of the Cretaceous period, some isolated species made their appearance, which have persisted to the present day. Starting from the Eocene period, their number rose gradually to 20, 60, 80, 90, 95, and 99 per cent., although it is not yet possible to demonstrate an equally regular gradation for all the classes. But however gradual may have been this passage from the geological faunas and floras to existing nature in the south of Europe (according to Philippi), it is very possible that in other countries a great portion of the series of intermediate beds may be wanting, and that consequently in these regions the distinction between the marine formations belonging to these two periods may appear far more marked than in Europe. In the same way, the separation of two older formations may be far more distinctly marked in one country than in another, for perfectly analogous reasons. This gradual passage from the ancient creations to the existing one does not manifest itself solely in the constantly increasing proportion of identical species, but also in the constantly increasing differentiation of the floras and faunas in accordance with zones, from the Eocene period to the present day. The formation of local floras and faunas, from the Eocene epoch to the Pliocene and Diluvian epochs, exhibited the same local characters as the floras and faunas of the present day : already each country was inhabited by the same characteristic families, the same genera, and a great part of the species which we find dwelling there at present. The most recent tertiary strata of England contain a testaceous

fauna which agrees especially with that of the Northern Ocean; the fauna of these same strata in Italy finds its congener in the existing fauna of the Mediterranean; in the West Indies we find the fauna of the existing sea agreeing for the most part with the tertiary fauna of the most recent of the islands. The bone-caves of Europe and the north of Asia are especially rich in remains of bears, hyænas, oxen, deer, and elephants,—that is to say, genera, species of which (although generally distinct from the diluvian species) still live for the most part in the same countries. In the caverns of South America we find the remains of Platyrrhine Quadrumana and of Edentata predominating, and even, as regards the latter, remains belonging to genera which still exist in that country, or which are very nearly allied to existing genera; some species even are identical. In the bone-caves of Australia, lastly, only bones of Marsupials have been found; and we know that at the present day we scarcely find any Mammalia on that continent which do not belong to the Marsupial division. One of the most remarkable proofs of the gradual passage from one period to the other is derived from the study of the ancient forests of *Taxodium distichum* in Louisiana (which, however, have for the most part existed in the present epoch).

The appearance of Dicotyledonous vegetation at the close* of the Cretaceous and commencement of the Tertiary period has been repeatedly represented as an event of immense importance for the development of the whole terrestrial fauna. Its importance is, in fact, incalculable in comparison with the characters to which we are compelled to have recourse in order to separate the Tertiary from the present period, and which are of so subordinate a nature. Thus one is often tempted to throw back the limits of the most recent period to this moment, and to confound the tertiary and recent strata in a single common period. In fact, in order to distinguish the Tertiary period from the actual epoch, we are forced to have recourse to one or other of the three following events, which probably indeed followed each other very closely, but which we cannot show to have been synchronic:—

1. The last appearance of existing plants and animals;
2. The last extinction of ancient species without the intervention of man;
3. The appearance of man himself.

The date of these three events can only be determined by the investigation of the fossil remains which come to our knowledge.

* Not only in the Upper Chalk of Germany have *Credneriæ*, &c., been found, but the *Lower* Cretaceous beds of Aix-la-Chapelle have yielded numerous leaves of Angiosperms.—Ed. *Annals.*

But this is a difficult theory; for the results of our investigations in this direction can never be regarded as definitive, besides that in this case we have probably to do only with very small chronological differences.

The marine Pliocene beds also contain species of Mollusca foreign to the previous periods (see Philippi, Wood, and D'Orbigny), united with others which already existed in the Miocene period; these have consequently made their appearance in the course of the Pliocene epoch. The lacustrine Diluvian beds present analogous facts as regards the terrestrial Mammalia. Bones identical with Diluvian remains have been found in the sub-Apennine Miocene sands and in the Mammaliferous crag of England. But no one has yet succeeded (and perhaps no one ever will succeed, from the want of constant characters) in determining at what point in the Pliocene strata these latter species appeared.

With the close of the Pliocene and Diluvian formations, the last animal and vegetable species which became extinct, independently of the action of man, disappeared; for in the strata of alluvium we only meet with the remains of species still actually in existence. It may, however, be objected to this view that, in the most recent Pliocene strata, the number of extinct species only reaching a very small per-centage, the determination of the age must become very uncertain, owing to the organic remains not being abundant. In fact, in this case it may easily happen that the rare extinct species have not been preserved in the locality under examination, although they may have been in others. We consequently run the risk of regarding as alluvium, strata which are in fact Diluvian or Pliocene, and of employing as a proof, the very point which we have to demonstrate. We are by no means sure that such errors have not been committed in cases which have been employed to decide the question. Lastly, how can we believe, after all the facts above cited, that the last 5, 4, 3, or 2 per cent. of the extinct species of the Pliocene population ceased their existence at the same moment under the equator and at the pole, at the bottom of the ocean and on the surface of the continents?

This is a question as difficult to settle, as to know whether man existed simultaneously with extinct species which have ceased to exist without any historical intervention on his part, or whether he has only appeared after their extinction. The appearance of man, who has had so great an influence upon the present state of our planet and upon the whole development of nature—the entry upon the scene of the world of this "lord of the creation," for whose reception all the rest could only have been a preparatory work, is an event which one would willingly have taken as the starting-point of a new era in the history of the world. It is true that human bones and fragments of artificial objects have

frequently been found mixed with the remains of Diluvian animals: but it has been thought that these facts could be got over by the hypothesis that these bones were not in primitive relations of association, but had been brought together at a subsequent epoch by currents of water; or, at least, it has been objected that the nullity of such a hypothesis cannot be demonstrated. Sir Charles Lyell in particular has endeavoured to explain the juxtaposition of human bones with Diluvian remains observed in Louisiana by Dickeson, by means of the disintegration of beds of clay in consequence of subterraneous erosions in a locality where Indian graves existed above Diluvian remains. The following observations would be more difficult to refute, if they had been surrounded by all the necessary guarantees. In a bone-cave in Brazil, M. Lund found a skull similar to that of the present aborigines, together with other human bones, amongst bones of *Platonyx* and *Chlamydotherium*. All the remains were petrified in the same way, penetrated by perfectly similar ferruginous incrustations, and presented the same metallic fracture. Out of twenty-four bone-caves in Brazil, M. Lund states that in six he found human bones associated with the remains of extinct animals; and although these observations could not be regarded in the light of absolute proof, M. Lund was inclined to think that these men and these animals had lived at the same time.

We must also mention here the juxtaposition of human bones, fragments of pottery, and other artificial products, with remains of extinct mammalia in the clay and osseous breccia of Bize, near Narbonne, according to Marcel de Serres, Tournal, and Lecoq; the analogous observations of M. Schmerling in the bone-caves of Louvain; those of M. Marcel de Serres in the caves of Mialet; the discoveries of the same nature in the recent volcanic matters of La Denise, near the Puy in Auvergne; and especially those of the rock-clefts of the Würtemberg Alb, in which five human molars have been found in the deepest parts, and in a state of fossilization identical with that of the bones of *Hippotherium*, *Tapirus*, and *Mastodon* found beside them,—facts which are guaranteed by Jaeger, Kurr, and Quenstedt. One circumstance alone might give rise to some scruples—namely, that these five teeth are all identical in form, and that, although they correspond with the last molar of the lower jaw (in the Mongols, the Finns, and the Negroes), they present a greater resemblance to each other than to this tooth*.

All the cases just cited are of such a nature, that a person destitute of any preconceived opinion would adopt without hesitation the notion of the simultaneous existence of human bones and

* See also Mr. Prestwich's paper at p. 230 of our present Number.—Ed. *Annals.*

remains of fossil animals in the same strata. Nevertheless any one who chooses to submit them to the most severe criticism may still leave the door open for certain doubts.

It is therefore useless, in our opinion, to speak of those cases in which the pretended discovery of human bones, going back to the Diluvian epoch, or even to a still more ancient period, has been completely refuted. Nor shall we dwell upon the traditions which are preserved by the inhabitants of New Zealand and Madagascar with regard to the existence of gigantic birds, such as the Moa (*Dinornis*) and the *Æpyornis* in remote countries—birds of which we now find the eggs and bones in strata of very recent origin; for it is very possible that these traditions repose merely upon the existence of these fossil remains, and in any case they are not supported by sufficient proofs*.

Nevertheless all these facts, although they do not prove irrefragably the coexistence of man with species of animals now extinct, certainly deserve serious consideration. If, in the present state of science, we collate them with the discovery mentioned in this work, of the skull of an Indian at a great depth in the Cypress-deposits of Louisiana†, we cannot but see that it

* In the case of the Moa, Mr. W. Mantell's late observations support the statements as to the cotemporaneity of man with this great bird.—Ed. *Annals*.

† The author alludes to the following facts. Messrs. Dickeson and Brown have discovered in Louisiana a deposit of fossil Cypress-trunks (*Cupressus disticha*, Linn., *Taxodium distichum*, Rich.) belonging to the same species which still exists in the regions exposed to the inundations of the Mississippi. This deposit is formed of ten layers of Cypresses, arranged vertically one above the other, and separated by layers of earth. Ten trunks of great diameter have been met with, for each of which the counting of the woody layers of growth gave a duration of about 5700 years. Above the most recent of these Cypress-beds there now grows a forest of evergreen Oaks, the age of which is estimated at 1500 years. Mr. Dowler (Jameson's Journal, 1854, lvii. pp. 374, 375) takes these facts as the basis of the following chronological calculations. The soil formed by the alluvia of the river originally produced only herbage; it was a vast bog with a moving soil. It was only by degrees, when the soil had been elevated and become more solid, that the Cypress-forests could establish themselves upon it. We know (thanks to the ancient data of Strabo) that the Nile, in the space of seventeen centuries, has only elevated the soil of Egypt, by its deposits of alluvium, at the rate of five feet in a century. Adopting a similar standard of measurement, we should have to suppose that it was only at the end of 1500 years that the soil of the moving bog became sufficiently firm to support Cypresses. Now, if we consider that some of the Cypresses which we find in this fossil forest attained the very great age of 5700 years, and if we pay attention to the fact that, for each of the ten layers of the deposit, we are compelled to assume generations of Cypresses succeeding one another, perhaps in great number, to be afterwards thrown down and left to decompose before the period at which the trees still actually living were developed, we shall not be charged with exaggeration in calculating for the duration of the deposition of each bed

is very difficult to establish a clearly-marked line of demarcation between the Tertiary epoch and the present.

New Results.

In 1848 and 1849, we had already indicated, in the 'Index Palæontologicus' (second part, pp. 746–913), several of the results contained in the present work with regard to the appearance of organisms on the surface of the earth, but without

---

a period of time answering at least to two generations of Cypresses. We see therefore that each of the forests which gave origin to the formation of one of the beds of this deposit lasted at least 11,400 years, before, being buried in the soil, there was a fresh irruption of the waters and formation of a new bog. The marshy soil of this new bog became solidified in its turn, and enabled to produce a new forest of Cypresses, the duration of which was not inferior to that of the former. Then this forest was buried in its turn, and the same phænomenon was repeated ten times in succession. For the last of these alternations, therefore, calculation gives the following result:—

Formation and solidification of the bog	1,500	years.
Duration of two generations of Cypress	11,400	„
Duration of the existing forest of Oaks after the drying and elevation of the soil.....	1,500	„
	14,400	„

The first nine times there was no desiccation and elevation of the soil after the development of the forests of Cypress, and the production of intermediate oak-forests was not possible. But as the depressions of the soil which terminated the existence of each forest of Cypress often produced a depression of the surface far below the level of the original bog, we may without much chance of error retain this space of 1500 years for each of the ten preceding periods, and we find then that the formation of the entire deposit required a period of time equal to $11 \times 14{,}400$, that is to say, 158,400 years; and during the whole of this immense period, the vegetation of the country has for the most part retained the same characters! At New Orleans, at 16 feet below the soil, in the fourth of these beds from the surface, there has been found a well-preserved human skull, corresponding perfectly in its form with the skulls of the actual aborigines of America, and accompanied by the remains of burnt wood. From this we must conclude that this country was inhabited 57,600 years ($4 \times 14{,}400$) ago by men of the American race.

Such is Mr. Dowler's calculation. It is true that several elements of this calculation are somewhat hypothetical; but the facts suffice to show, with very great probability, the immense duration of an epoch posterior to the Diluvian period, at least if we do not choose to regard the strata below the human skull as still belonging to the cænolithic age—an opinion which does not appear to be supported by local observation in Louisiana. Moreover, it is worth while to remark that this Cypress (*Taxodium distichum*), upon which it would appear that we may rest, in order to demonstrate the long duration of the post-diluvian epoch, is one of the three species the existence of which may be traced, according to M. Göppert, upon the soil of Europe, from the upper Miocene to the actual epoch (under the name of *Taxodites dubius*).—É. Claparède.

representing these facts as flowing from a positive law—as resulting from a common cause. Even then we pointed out the passage of species from one bed to another, the variability of the duration of their existence, and the increase in the number of species, genera, orders, and classes in recent periods,—circumstances which support the idea of the existence of a hotter and more uniform climate in the ancient periods. Even then we indicated the progressive advance to perfection of the different subkingdoms by the successive appearance of more perfect groups and the extinction of other groups of inferior organization, and the influence of the external conditions of existence upon the successive appearance of the various types of animals and vegetables upon the surface of the earth,—understanding by these external conditions, atmospheric conditions and those of configuration of soil or the action of other organized beings. Before 1848, these different points of view had never been carefully studied in detail; and those which, like the gradual development of creation from more simple to more complex organization, had been the object of special investigations on the part of other authors, appeared to lead to results agreeing but little with older knowledge. The conclusions at which we arrived in the 'Index Palæontologicus' remain true now as then. Recent researches confirm them in all points.

Nevertheless the present work is rich in new results. It places the law of adaptation of the successive faunas and floras to the external conditions of existence, as a fundamental law which governs all the others. Considered on its negative side, this law is absolute, and excludes every phænomenon which would contradict it; but considered on its positive side, it allows free play to other laws subordinated to or independent of it. This work shows us the necessity of the simultaneous appearance of plants and animals, and teaches us that all the phænomena resulting from this fundamental law flow from it in a necessary and direct manner. It consequently confirms, by palæontological proofs, the geological theory in favour at the present day. By positive and incontestable facts, it overthrows the old idea of distinct faunas and floras confined within perfectly limited strata, determined by lithological limits remaining the same over all the surface of the globe. It demonstrates the inequality of duration of species coexisting in the same stratum. It presents the law of terripetal evolution as an expression of the gradual transformation of the surface of the globe and of its influence upon the totality of the successive characters of the floras and faunas. It establishes the second fundamental law, namely, that of progressive development (advancing in concert with the progression which might result simply from the terripetal law).

It exhibits in detail and in a decisive manner the importance of the appearance of the angiospermous Dicotyledons as a condition of existence for the whole terrestrial fauna. Lastly, it indicates the importance of the synchronic relations which existed between the ascertained depressions of the soil, combined with the emanation of a great quantity of carbonic acid eliminated immediately by the formation of coal, and the existence of the singular forests of *Stigmaria*, connected with a vegetation composed only of vascular Cryptogamia and gymnospermous Dicotyledons, to the exclusion of the Angiospermia*. These peculiar conditions of vegetation seem to have made their appearance again, although with a very local development, in the course of the Jurassic period. We are convinced that the office of these forests was to maintain the atmosphere in a respirable state at a period when carbonic acid was emitted in greater abundance than at the present day, and even to render it more suitable for respiration, although positive proofs of this are wanting. An abundant vertebrate fauna with an active respiration would in course of time have acted injuriously in the opposite direction. If this opinion should be confirmed, the fact of the progressive development of the vegetable kingdom would enter, at least partially, into dependence upon the law of adaptation of the successive creations to the external conditions of existence. By this the unity of the laws and phænomena could not but gain.

The results at which we have arrived rest upon the actual state of our knowledge of the fossil world. New discoveries may therefore at any time introduce modifications of them. Nevertheless the general laws which we have established repose upon too numerous facts to allow any exceptions which may hereafter be discovered to suffice for their complete overthrow. Although, in the creation of organized beings, nature may have followed the course which we have indicated, we cannot, however, but suppose that some exception, some deviation from the rule may have taken place in consequence of causes unknown to us. The phænomena which occupy us here are by no means of such a nature that we may deduce them from a fundamental law with the same certainty that we can deduce the fall of a body or the orbit of a planet from the law of universal attraction. The causes which preside over these phænomena are too manifold and too dissimilar to allow us to calculate the result with certainty *à priori*. But even if we supposed that a perfectly strict law was at the basis of all these phænomena, our knowledge of the remains enclosed in the strata of the earth's crust can never be otherwise than fragmentary. We can never be sure that certain facts do not escape us, the revelation of which

* See previous note at p. 177.—Ed. *Annals.*

would be of high importance to the development of our knowledge.

However the results at which we have arrived may be received, we have only searched for truth. The laws that we have developed as resulting from a geological theory, had revealed themselves long since to our eyes in nature; for during many years we have ever been guided by one single motive—

"*Naturâ doceri.*"

XIX.—*On the Development of Roots, and the Exfoliation of the Cellular Coats of their Extremities.* By Arthur Henfrey, F.R.S.

In the 'Journal of the Royal Agricultural Society of England,' vol. xix. part 2, published in January last, there is an essay on the Structure of Roots, by myself, in the latter part of which is described the mode in which the extremities of roots elongate, and the special arrangements by means of which they are enabled to penetrate the soil. The same subject has more recently been dealt with by MM. Garreau and Brauwers, who appear to have been ignorant of the existence of my paper above referred to; these authors have made some extensive investigations on a further point connected with these root-ends, viz. the possibility that the exfoliated tissue may constitute an excretion capable of exerting an injurious influence upon the same species, and so account for some of the most puzzling phænomena relating to the rotation of crops. As the subject is one of great physiological interest, it may be worth while to extract from the 'Agricultural Journal' those portions of the above-mentioned essay which relate to the anatomy and development of roots, at the same time that I present a translation of the memoir of MM. Garreau and Brauwers. The statements in my own paper are made in somewhat general terms, as it was prepared for a somewhat "popular" class of readers; but they were based upon an original series of investigations which furnished facts in all respects identical with those related in detail by the French authors, to whom, however, exclusively belongs the merit of that part of the inquiry concerning the nature of the substances cast off by the exfoliating radicles.

"The root, as developed in the great majority of plants, presents a highly organized structure, made up of various kinds of true cellular or parenchymatous tissue, together with those kinds of elementary tissue which, under the names of wood-cells, vessels, and ducts, form the hard parts of plants. As a rule, we may divide the internal structures of a root into two regions—